AMATEUR SATELLITE REPORT

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AMSAT's® *Newsletter for the Amateur Radio Space Program*

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AO-10 Status Report

by Peter Guelzow, DB2OS

[In ASR#135 we reported AO-10 was QRT apparently from lack of solar illumination. That report appears to have been in error. AO-10's beacons continue to be heard. In fact the strength of both is gaining as we have apparently past the worst sun angles. In the following status report, DB2OS, one of the AMSAT DL team, reports the latest findings.—Ed]

Sunangle and especially illumination are now increasing rapidly. The minimum illumination was around 8% of the nominal value on 12 Oct. On 25 October we will have 25% illumination. At Nov 9 sunangle reaches 60 degrees and we then have 50% of the nominal power available. Beginning December, sunangle lies around 35 degrees and illumination is 84%. By 11 Jan 87 we will have 0 degrees sunangle with 100% power! By the end of March, 1987, sunangle and illumination will decrease with minimum illumination of 9% on Apr. 12 (again 85 degrees sunangle).

According to James Miller, G3RUH, the estimated attitude of OSCAR-10 was 180/20 on 09 Sept. 86. Currently it's about 175/17 due to precession. The attitude vector lies close to the Ecliptic which is characterized by a 26 week cycle of illumination running up and down from 100% to under 10%.

After the current minimum we may have a good time when the IHU may again be commandable. But it is important that we can switch off the Engineering and General Beacons until mid-November. On 30 Nov. 86 OSCAR-10 goes into eclipses (illumination more than 75%) which will continue right through 1987. In December, OSCAR-10 enters eclipses at around MA 205 and exits at MA 235 for a duration of 60 minutes. In February, the duration of the eclipses decreases to 30 minutes with start around MA 245 and end at aproximately MA 255. In November/December 1987 the duration of the eclipses will increase again to 100 minutes.

Currently work is concentrating on trying to reset the IHU and make it again commandable. If this happens and the memory condition allows loading of short programs, it could be possible to bring the satellite again under control of the IHU. A short computer program is needed to switch the transponder off for recharging batteries just before the satellite enters eclipse.

IFRB Filing Specifies New RS Birds

As mentioned in *ASR*135, a filing at the International Frequency Registration Board (IFRB) in Geneva appears to refer to RS-9 and RS-10. These new Russian Amateur Radio satellites are apparently now complete and awaiting launch. The following is a more detailed extract from the IFRB filing.

In the U.S.S.R., work is in progress for the development of Amateur-Satellite Service Systems (ASSS). In particular, it is planned to launch one or two amateur satellites, designed for use by Radio Amateurs throughout the world and also for educational and scientific experiments.

Orbital information relating to the satellites

Inclination of the orbit:	83 degrees
Period:	105 minutes
Altitude of the apogee:	1,000 km
Altitude of the perigee:	1,000 km
Number of satellites:	1 or 2

Uplink Information

Transponder bandwidth — 40 kHz in one section of the range:

1. 21.260 - 21.300 MHz
2. 21.210 - 21.250 MHz [Apparently Mode K uplink—Ed]
3. 21.160 - 21.200 MHz

Transponder bandwidth — 40 kHz in one section of the range:

1. 145.960 - 146.000 MHz
2. 145.910 - 145.950 MHz [Mode A uplink—Ed]
3. 145.860 - 145.900 MHz

Uplink power required: Depends upon the design of the station available to the amateur. For good quality relay, an equivalent isotropically radiated power (e.i.r.p.) of not more than 100 W will suffice.

Satellite receiving antenna: For all modes — a half-wave dipole, gain G = 2 dB, width of radiation pattern: 80 degrees.

Noise temperature of the receiving space station: 2,000 K

Downlink Information

Transponder bandwidth — 40 kHz in one section of the range:

1. 29.460 - 29.500 MHz
2. 29.410 - 29.450 MHz [Mode A downlink—Ed]
3. 29.360 - 29.400 MHz

Transponder bandwidth - 40 kHz in one section of the range:

1. 145.960 - 146.000 MHz
2. 145.910 - 145.950 MHz [Apparently Mode T downlink—Ed]
3. 145.860 - 145.900 MHz

Simultaneous transmission on the bands 29.360 - 29.500 MHz and 145.857 - 146.000 MHz [Apparently simultaneous Mode A and T—Ed]

Beacons:

On each transponder section two beacons operate in the following center frequencies:

1. 29.457 and 29.500 MHz
2. 29.407 and 29.453 MHz
3. 29.360 and 29.403 MHz

[or]

1. 145.957 and 145.997 MHz
2. 145.907 and 145.953 MHz
3. 145.857 and 145.903 MHz

Power characteristics of the transmission

Maximum spectral power density:

29.260 - 29.500 MHz: -41 dBW/Hz
145.857 - 146.000 MHz: -39 dBW/Hz

Characteristics of space station transmitting antenna

For all modes, antenna gain: 1 dB, omnidirectional; linear ploarization

Characteristics of receiving earth stations: These depend on the facilities available to amateurs. It will suffice to have a receiving antenna with a gain of 1 to 2 dB and a receiving system with an equivalent noise temperature of 1,000 K to 15,000 K.

Short Bursts

• According to DB2OS and G3IOR, UA3CR's trip to Antarctica has been delayed or cancelled. Leo (UA3CR) says they currently have no contact to the Drushnaya Station. Communication on hf is impossible due to a snow-storm. Moreover, satellite pictures show that the ice-shelf on which the station is located has broken away and sunk. It is unknown whether there was any loss of life or casualties associated with this highly extraordinary event. Possible rupture of the ice station from the larger ice flow was first reported to AMSAT October 8 by W1BIH who noted reports from USSR sources.

• Paul Roemer, KG6LC, Manager of AMSAT's Software Exchange, announces the availability of the "Amiga Orbits" tracking program for the Commodore Amiga computer. This program has been translated from the original W3IWI "Orbits" by AMSAT member Paul MacDonald, WA1OMM, of Nashua, NH. The program is menu driven, and can store data for as many as twenty satellites. The program is available now for a nominal donation ($30 for members, $40 for nonmembers).

ASR *Spotlight On: James Richard Miller, G3RUH*

by Pete Killingsworth, KD7WZ

James Miller, G3RUH, describes himself as: "A polymath with some 20 years of work in all aspects of modern systems." His areas of expertise cover a wide range of technology including digital and analog communications systems, coding, modulation and demodulation, navigation, systems analysis, digital signal processing, rf engineering, software design and "number crunching." He enjoys writing technical articles for *OSCAR NEWS*, the bi-monthly technical and news journal of AMSAT-UK and other publications (see bibliography). He puts his broad technical background to good use by designing and selling demodulators for UoSAT and OSCAR-10, a modem circuit board for the new FO-12, computer software and 70 cm helix antennas. He is currently a member of the AMSAT Phase 4 Satellite Study Team and is working toward a detailed definition of that satellite.

James acquired his first radio, a crystal set, at age 11. A few years later he overheard two hams talking on short wave and says that he "never looked back." He was first licensed as an Amateur Radio operator in 1962. He became interested in satellite operation in 1981 with the launch of UO-9. James says that he had been inactive as a ham for a few years when he read about UO-9 going up. He thought it would be fun to write a program to compute the satellite orbital data from Doppler shift measurements. His accurate calculations were used by the University of Surrey until data became easily available from NASA.

The G3RUH OSCAR station is up-to-date and highly computerized. James uses a Yaesu FT-726R with 2 meter and 70 cm linears, a speech processor, an IBM PC and other computers, a TNC-2 with FO-12 modem, OSCAR-10 PSK system and UoSAT data demodulator. His antennas are a 2 meter 10XY yagi with a muTek masthead preamp and a 70 cm 16 turn helix, also with a muTek masthead preamp. The antennas are positioned by Kenpro rotators under real-time computer control. Much of the equipment and all the software he uses is of his own design.

On the air, James usually confines himself to purposeful communication such as schedules to discuss specific things, breaking into QSOs with up-to-date technical information or uplinking AMSAT-UK/RSGB news items via OSCAR-10. But he has been known to occasionally call CQ. James admits to being, "More interested in the technology than the QSOology."

Over the years James says he has spent thousands of hours monitoring satellite telemetry. He recently developed new methods to improve attitude determination speed and accuracy for AO-10. These are now in daily use by the active command stations and will also be useful for Phase 3C.

In 1982-3 he designed a "matched filter" demodulator for UoSAT because he felt that zero-crossing detectors and converted two-tone modems were not very satisfactory due to their inadequate noise rejection. He also designed the OSCAR-10 PSK demodulator in 1983. His latest demodulator project was the development of the FO-12 modem for use with an AX.25 TNC to access Mode JD.

James tells about how he had endless trouble trying to satisfactorily phase crossed yagis for circular polarization. He kept getting mediocre performance on AO-10 and decided that a helix was needed. He found that the theory on helix antennas is well established but it doesn't solve any of the mechnical design problems. He took on the challenge and came up with a 70 cm helix antenna that has worked flawlessly for three years and is still in mint condition. James states that dozens of other OSCAR operators, including one AO-10 command station, have used his design with excellent results.

On the software front, James wrote a popular program called PLAN-10, which is used as a planning tool, giving the usual perameters needed to successfully work through a satellite. He states that the chief virtue of PLAN-10 is its density of comment and clarity of style, designed so that users can base their own program around it for any satellite or application. He also produced SATFOOT, a graphics program which shows up to 10 satellite footprints simultaneously gliding across a precision colored world map.

Looking toward the future, James is working on a project he calls "Loonbounce." His objective is to achieve digital communication on EME, using not more than 20 dB of antenna gain on 70 cm and 100 watts of power. He says that Loonbounce is looking good so far. He also plans to begin work on writing some good satellite utilities that properly exploit the potential of the IBM-PC. A final word of advice from G3RUH: "Don't panic! Self-training does not cause blindness."

Selected Bibliography by J. R. Miller, G3RUH

1. Data Decoder for UoSAT, *Wireless World*, Vol. 89 No. 1568, pp 28-33, May, 1983.
2. Helical Antennas for 435 MHz, *Wireless World*, Vol. 91 No. 1592, pp 43- 46, June, 1985. (cover story)
3. A PSK Demodulator for OSCAR-10, *Ham Radio Magazine*, pp 50-62, April, 1986.
4. JAS-1 Modem, *Oscar News*, No. 61, pp 19-22, September, 1986.

TECH TIP #3: Smoothed Keplerian Elements

by James Miller, G3RUH

It's not widely appreciated that those Keplerian elements helpfully provided by NASA aren't quite as accurate as they appear. All those decimal places create a false sense of security! The Keplerian elements of thousands of space objects are derived from frequent radar range and range-rate measurements and are self-consistent to facilitate tracking for a very short time — a few days or weeks.

But satellites like AO-10 are in nice, stable orbits so the elements appear to hold well for quite a while. However, when you take a close look at successive sets of Keplerian elements you get quite a surprise. Take Argument of Perigee for example. For AO-10 we expect this to change slowly at an average rate of around 0.3 degrees per day — which indeed it does. But carefully plot a graph of Argument of Perigee against time and you'll see the points jitter around the steady slope with a variation of some 0.2 degrees RMS. Individual points may be off-slope by as much as 0.5 degrees. So much for all those decimal places!

You can perform the same exercise with RAAN and the other parameter which changes continuously, Mean Anomaly. Steady parameters (Inclination, Eccentricity and Semi Major Axis) can simply be averaged. By plotting the graphs — or doing the equivalent manipulation by computer program you can reveal a SMOOTH EPHEMERIS which has real accuracy and long term utility.

Here's a set I promise you'll find workable for the balance of 1986. It's based on 11 NASA Keplerian sets from April 1st to September 4th 1986.

SMOOTHED EPHEMERIS FOR OSCAR-10 de G3RUH

			1 sigma
Epoch Year:	1986	Year	Uncertainty
Epoch Time:	247.02632	Day	------------
Inclination:	26.7980	deg	0.01
RA of Node:	61.5180	deg	0.10
Eccentricity:	0.6031	-	0.0003
Arg of Perigee:	141.1207	deg	0.12
Mean Anomaly:	0.0	deg	0.29
Mean Motion:	2.05856082	rev/day	0.000007
Decay Rate:	0	rev/day/day	
Epoch Rev:	2426	-	
Semi major axis:	26104.0	km	0.5
RAAN dot:	-0.1652	deg/day	0.0008
Arg Peri dot:	0.2716	deg/day	0.001

Digital Communications Consultant Sought For Africa Duty

How would you like to spend the grueling winter in sunny Ethiopia where you will, among other things, integrate packet radio technology into the existing two-way radio network operated by the Relief and Rehabilitation Commission (RRC)? You will work under the auspices of VITA (Volunteers In Technical Assistance) with the local CARE mission in Addis Ababa and build on the successful demonstration of digital communications technology earlier this year. Training of RRC staff is involved as well as helping to upgrade the existing radio network.

The job is for approximately three months, is PAID (details to be worked out), and tentatively starts January 1, 1987. If you are interested — or know of somebody who is — please send basic biographical information to the following address:

Gary Garriott WA9FMQ
Manager - Information Technology
VITA
1815 N. Lynn Street, Suite 200
Arlington, VA 22209

Keplerian Elements

Satellite	OSCAR-9
Catalog number	12888
Epoch time:	86283.45570783
Fri Oct 10 10:56:13.156 1986 UTC	
Element set:	945
Inclination:	97.6560 deg
RA of node:	288.6368 deg
Eccentricity:	0.0003401
Arg of perigee:	47.7190 deg
Mean anomaly:	312.4342 deg
Mean motion:	15.28755784 rev/day
Decay rate:	1.568e-05 rev/day^2
Epoch rev:	27857
Semi major axis	6854.632 km
Anom period:	94.194247 min
Apogee:	490.316 km
Perigee:	485.654 km
Ref perigee:	3204.46435062
Fri Oct 10 11:08:39.893 1986 UTC	
Beacon:	145.8250 MHz

Satellite	OSCAR-10
Catalog number	14129
Epoch time:	86292.05981751
Sun Oct 19 01:26:08.232 1986 UTC	
Element set:	272
Inclination:	26.8544 deg
RA of node:	54.3247 deg
Eccentricity:	0.6032398
Arg of perigee:	153.1246 deg
Mean anomaly:	259.1205 deg
Mean motion:	2.05878556 rev/day
Decay rate:	-1.6e-07 rev/day^2
Epoch rev:	2519
Semi major axis	26103.562 km
Anom period:	699.441471 min
Apogee:	35473.016 km
Perigee:	3979.601 km
Ref perigee:	3213.19592728
Sun Oct 19 04:42:08.117 1986 UTC	
Translate freq	581.0047 MHz
Invert:	1
Beacon:	145.8090 MHz

Satellite	OSCAR-11
Catalog number	14781
Epoch time:	86287.26266782
Tue Oct 14 06:18:14.499 1986 UTC	
Element set:	176
Inclination:	98.1342 deg
RA of node:	352.4737 deg
Eccentricity:	0.0013896
Arg of perigee:	144.8020 deg
Mean anomaly:	215.4111 deg
Mean motion:	14.62075281 rev/day
Decay rate:	8.5e-07 rev/day^2
Epoch rev:	13976
Semi major axis	7061.693 km
Anom period:	98.490141 min
Apogee:	700.324 km
Perigee:	680.698 km
Ref perigee:	3208.29013808
Tue Oct 14 06:57:47.929 1986 UTC	
Beacon:	145.8260 MHz

Satellite	OSCAR-12
Catalog number	16909
Epoch time:	86286.59572280
Mon Oct 13 14:17:50.449 1986 UTC	
Element set:	15
Inclination:	50.0144 deg
RA of node:	63.3257 deg
Eccentricity:	0.0010965
Arg of perigee:	19.3218 deg
Mean anomaly:	340.7968 deg
Mean motion:	12.44393098 rev/day
Decay rate:	-2.5e-07 rev/day^2
Epoch rev:	768
Semi major axis	7866.846 km
Anom period:	115.719060 min
Apogee:	1498.701 km
Perigee:	1481.449 km
Ref perigee:	3207.60000941
Mon Oct 13 14:24:00.812 1986 UTC	
Translate freq	581.8000 MHz
Invert:	1
Beacon:	435.7970 MHz

Satellite	RS-5
Catalog number	12999
Epoch time:	86290.35457969
Fri Oct 17 08:30:35.685 1986 UTC	
Element set:	356
Inclination:	82.9626 deg
RA of node:	40.2552 deg
Eccentricity:	0.0010763
Arg of perigee:	149.7820 deg
Mean anomaly:	210.3923 deg
Mean motion:	12.05058813 rev/day
Decay rate:	1.2e-07 rev/day^2
Epoch rev:	21258
Semi major axis	8033.816 km
Anom period:	119.496242 min
Apogee:	1669.653 km
Perigee:	1652.360 km
Ref perigee:	3211.38906572
Fri Oct 17 09:20:15.278 1986 UTC	

Satellite	RS-7
Catalog number	13001
Epoch time:	86290.67977973
Fri Oct 17 16:18:52.968 1986 UTC	
Element set:	279
Inclination:	82.9599 deg
RA of node:	33.2156 deg
Eccentricity:	0.0023213
Arg of perigee:	70.9886 deg
Mean anomaly:	289.3682 deg
Mean motion:	12.08699501 rev/day
Decay rate:	1.3e-07 rev/day^2
Epoch rev:	21326
Semi major axis	8017.665 km
Anom period:	119.136311 min
Apogee:	1676.960 km
Perigee:	1639.737 km
Ref perigee:	3211.69601201
Fri Oct 17 16:42:15.437 1986 UTC	

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J. R. Miller, G3RUH, our "Spotlight" for this issue. Please see related story inside.

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